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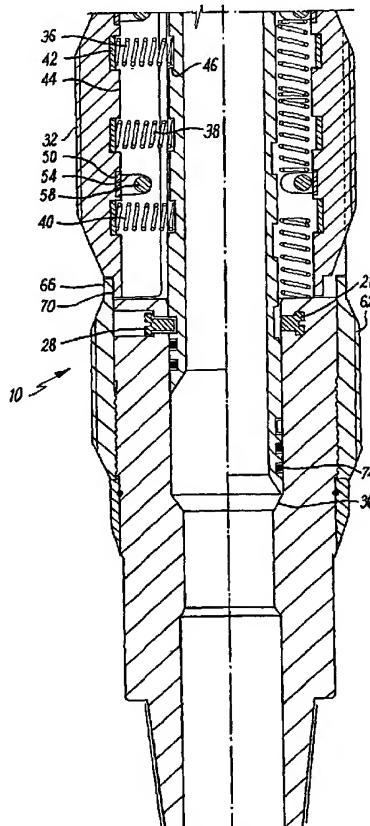
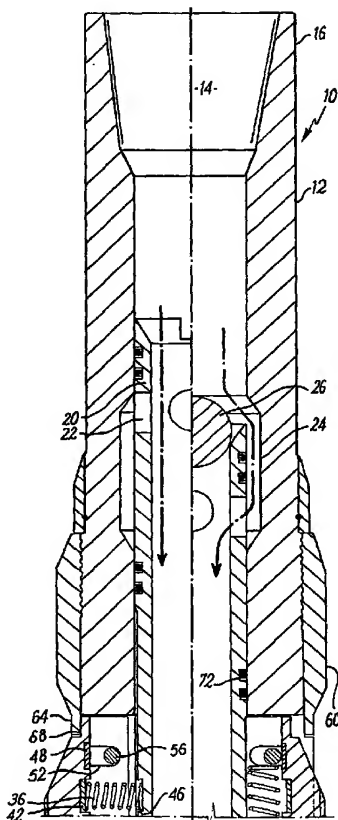
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[Continued on next page]

(54) Title: **DISENGAGABLE REAMER**



(57) Abstract: A downhole tool (10) for use in the removal of burrs or other unwanted material from an inner surface of a pipeline, well casing or other tubular. The tool has a plurality of milling elements (32), which may be biased against the surface or retracted from the surface to disengage the tool from the tubular. A drop ball mechanism with a fluid by-pass is described for disengaging the milling elements.



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*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

## DISENGAGEABLE REAMER

1

2

3 The present invention relates to apparatus and method for  
4 use in oil and gas exploration and production, in  
5 particular, but not exclusively, to a burr mill for  
6 selectively performing milling and/or burr removal within  
7 a well.

8

9 When an oil or gas well is drilled it is common to insert  
10 a liner or casing into the well in order to support the  
11 walls as the depth of the well is increased. In order to  
12 access oil or gas containing formation outside the  
13 casing, the casing is commonly perforated by means of  
14 explosives. As the casing is made of a hardwearing  
15 material such as steel, when perforation takes place the  
16 steel casing is deliberately damaged to provide access  
17 from the wellbore through to the formation and as a  
18 result, sections of the casing will be left with exposed  
19 metal shards or burrs directed into the wellbore.

20

21 Consequently, the insertion of any other tools into the  
22 wellbore are susceptible to damage due to collisions with  
23 or scraping against the burrs formed during perforation.  
24 In particular, delicate screens used for the filtering of

1 fluids downhole can easily be ruptured on contact with  
2 the burrs. It would therefore be advantageous to find a  
3 method of removing these burrs to avoid damaging tools  
4 downhole.

5

6 It is already known to attach a mill to a drill string  
7 and by rotation of the drill string through the wellbore,  
8 burrs may be removed. These tools have the disadvantage  
9 that once they have successfully milled off the burrs  
10 they become redundant within the well and if left in  
11 place they can both cause unwanted wear on the casing and  
12 be exerted to unwanted wear on the milling surfaces of  
13 the tool as they are subjected to continuous buffering on  
14 the inside diameter of the casing.

15

16 It is an object of at least one embodiment of the present  
17 invention to provide a downhole tool for the removal of  
18 burrs or other unwanted debris from inside a wellbore  
19 which obviates or mitigates disadvantages in the prior  
20 art.

21

22 It is an object of at least one embodiment of the present  
23 invention to provide a downhole tool in the form of a  
24 burr mill which is disengagable so that the milling  
25 elements can be removed from the surfaces on which the  
26 burrs occur.

27

28 According to the first aspect of the present invention,  
29 there is provided a downhole tool for the removal of  
30 burrs and other unwanted material from an inside surface  
31 of a pipeline, well casing or other tubular, the tool  
32 including a tool body mountable on a work string, the  
33 body supporting a plurality of milling elements which  
34 mill the surface and retraction means for disengaging the

1 milling elements from the surface when milling is no  
2 longer required.

3

4 Thus, the tool is capable of providing a milling action  
5 to remove burrs when the tool body is rotated on a drill  
6 string as it enters the well and at any location where  
7 the string requires to be circulated but no milling is  
8 required, the milling elements can be disengaged and  
9 retracted back into the tool to stop their contact with  
10 the inside surface of the casing or liner.

11

12 Preferably the tool includes biasing means to bias the  
13 one or more milling elements in an outward radial  
14 direction. Preferably the milling elements are biased  
15 into engagement with the inside surface. Advantageously  
16 the biasing means comprise springs held under  
17 compression. Preferably also the tool includes an outer  
18 sleeve, the outer sleeve including one or more apertures  
19 through which the milling elements protrude. More  
20 preferably the apertures include overhanging portions  
21 which engage a part of the milling element and limit the  
22 radial movement of the milling element. By limiting the  
23 radial movement of the milling elements the springs are  
24 held in compression.

25

26 Preferably the retraction means comprises release means  
27 to remove the compression on the springs. Advantageously  
28 the release means operates by re-positioning the springs  
29 relative to the tool body. The release means may comprise  
30 an inner sleeve mounted in a central bore of the tool  
31 body into which are located ends of the springs. The  
32 springs are re-positioned by virtue of movement of the  
33 inner sleeve from a first position in which the milling

1 elements are engaged to the inside surface and a second  
2 position where the milling elements are disengaged.

3  
4 Preferably the inner sleeve is held in the first position  
5 by at least one shear pin. More preferably the inner  
6 sleeve includes a ball seat into which a drop ball can  
7 locate. Once located a pressure build up behind the ball  
8 will force the ball against the drop inner sleeve until  
9 the shear pin shears and the inner sleeve falls into the  
10 second position.

11  
12 Preferably the retraction means further includes one or  
13 more magnets. Preferably the magnets hold the milling  
14 elements against the tool body when disengaged.

15  
16 Preferably also the tool includes a by-pass means which  
17 maintains fluid flow through the central bore by allowing  
18 fluid to by-pass the drop ball when the tool is  
19 disengaged. Advantageously the by-pass means comprises  
20 one or more radial ports in the inner sleeve and one or  
21 more recesses in the tool body. When the inner sleeve is  
22 in the second position, the one or more recesses are  
23 located adjacent the drop ball and one or more flow paths  
24 are created as the one or more ports align with the one  
25 or more recesses thereby directing fluid around the drop  
26 ball.

27  
28 According to a second aspect of the present invention,  
29 there is provided a method of removing burrs or other  
30 unwanted debris from an inside surface of a pipeline,  
31 well casing or other tubular, the method comprising the  
32 steps:

33

- 1 a) inserting into the tubular one or more milling  
2 elements;  
3  
4 b) biasing the one or more milling elements against the  
5 surface to provide a milling action when the  
6 elements are moved in relation to the surface;  
7  
8 c) disengaging the one or more milling elements from  
9 the surface to prevent further milling.

10

11 Preferably the method further includes the step of  
12 actively retaining the milling elements in a retracted  
13 position away from the surface of the tubular.

14

15 Preferably step (c) includes the step of dropping a ball  
16 into the tool to cause parts thereof to move in relation  
17 to each other and thereby re-position springs within the  
18 tool.

19

20 More preferably the method includes the step of  
21 magnetically retaining the one or more milling elements  
22 against the tool body when disengaged.

23

24 An embodiment of the present invention will now be  
25 described by way of example only with reference to the  
26 accompanying Figures in which:

27

28 Figure 1 is a schematic cross-sectional view of a  
29 downhole tool in both an engaged (LHS) and  
30 disengaged (RHS) position in accordance with an  
31 embodiment of the present invention;

32

1        Figure 2 is a top view of a milling element of the  
2        apparatus of Figure 1; and

3

4        Figure 3 is a sectional view through the line A-A'  
5        of Figure 1.

6

7        Reference is initially made to Figure 1 of the drawings  
8        which depicts a downhole tool generally indicated by  
9        reference numeral 10 according to an embodiment of the  
10       present invention. Tool 10 includes a tool body 12  
11       through which is axially located a central bore 14 for  
12       the passage of fluid through the tool 10. At an upper end  
13       of tool body 12 is located a box section 16 and at a  
14       lower end of tool body 12 there is located a threaded pin  
15       18. Box section 16 and threaded pin 18 allow the tool 10  
16       to be connected in a drill string (not shown).

17

18       Within the central bore 14 there is an inner sleeve 20.  
19       Inner sleeve 20 includes four ports 22 which when the  
20       sleeve is moved can locate across a recess 24 in the tool  
21       body 12 and provide an alternative flow path. This is  
22       illustrated in Figure 1 at the upper end of the tool  
23       where the inner sleeve 20 has been moved by the action of  
24       a drop ball 26 being placed in the central bore 14.

25       Inner sleeve 20 is kept initially in place by the use of  
26       shear screws 28. When ball 26 is dropped through the  
27       central bore 14, it lands on the ball seat at the upper  
28       end of inner sleeve 20. A fluid pressure build up behind  
29       ball 26 forces the ball 26 downwards with the result that  
30       the screws 28 shear under the force. Sleeve 20 then falls  
31       until it is prevented from exiting the lower end of the  
32       tool 10 by virtue of the lip 30.

33



1 Milling elements 32 are arranged around the tool body 12.  
2 In the embodiment shown there are three milling elements  
3 arranged equidistantly around the tool body as shown more  
4 clearly with the aid of Figure 3.

5

6 Referring to Figure 2, it is seen that each milling  
7 element has a milling surface which is arranged with  
8 projections to aid the milling action for the removal of  
9 burrs and other unwanted debris from the inside walls of  
10 the pipeline, liner or casing in use. Consequently, each  
11 milling surface 34 has a radial profile to provide a  
12 match to the pipeline wall (not shown). The milling  
13 elements 32 are not fixed to the tool body 12. The  
14 milling elements 32 are free-floating and are held in the  
15 extended position against the pipeline walls by virtue of  
16 springs 36, 38 and 40 located between the milling  
17 elements 32 and the inner sleeve 20. To aid the  
18 insertion of these springs 36, 38 and 40 when the tool is  
19 assembled, magnets 42 are located in recesses on a back  
20 surface 44 of the milling element wherein each spring 36,  
21 38 and 40 locates in the recess and is held in place by  
22 the magnet 42. The opposing end of each spring 36, 38  
23 and 40 is held in a narrow recess 46 on the inner sleeve  
24 20. Also located on the back surface 44 of the milling  
25 element 32 are additional retraction magnets 48 and 50.  
26 Magnets 48 and 50 are located adjacent elongate ports 52  
27 and 54 into which are located socket head cap screws 56  
28 and 58 whose purpose will be described hereinafter.

29

30

31 Milling element 32 is limited in radial movement by stand  
32 off sleeves 60 and 62. Each stand off sleeve 60 and 62  
33 has opposite handed threads thus in this embodiment stand  
34 off sleeve 60 has a left hand thread while stand off

1 sleeve 62 has a right hand thread. Each sleeve 60 and 62  
2 includes a lip 64,66 which engages the corresponding lip  
3 68,70 on the milling element 32 to prevent the radial  
4 movement. Thus, milling element 32 is biased radially  
5 outwards by the use of the springs 36, 38 and 40. As  
6 better shown in Figure 3, it will be appreciated that the  
7 springs 36 and magnets 42 may be paired up. Although  
8 those skilled in the art will appreciate that any number  
9 of milling elements may be used and the size and  
10 arrangement of the springs may be adjusted, as long as  
11 the overall effect is to bias the milling elements and in  
12 particular, the milling surfaces 34 outwardly.

13  
14 In use the milling elements 32 are arranged on the tool  
15 body 12 in the configuration shown to the left hand side  
16 of Figure 1. The tool 10 is attached to the drill string  
17 and the drill string rotated into the casing or liner.  
18 On entering the casing or liner the milling elements are  
19 in the expanded position by virtue of the springs 36, 38  
20 and 40 radially biasing the milling surface 34 against  
21 the inner surface of the casing. The milling element 32  
22 may move in relation to the diameter of the casing so  
23 that casing inner diameters of various sizes can be used  
24 with the tool. As the tool is rotated, burrs present on  
25 the inside wall of the casing will be dressed off and  
26 removed as will any other debris on the surface of the  
27 casing walls. When it is necessary to stop a de-burring  
28 or milling process but the drill string still requires to  
29 rotate to operate other tools which may be mounted  
30 thereon, a drop ball 26 is released into the central bore  
31 14 of the tool. The drop ball 26 will typically be  
32 released at the surface and travel through the central  
33 bore of the drill string to enter the tool 10 at its  
34 location in the wellbore. Drop ball 26 will close the

1 central bore 14 as it impacts on the inner sleeve 20.  
2 Fluid pressure will build up behind the ball 26 and the  
3 resulting force will cause the shear screws 28 to shear  
4 thereby allowing the inner sleeve 20 to fall towards the  
5 lower end of the tool. In falling the port 22 will  
6 locate over recess 24 in the tool body 12 so that flow is  
7 maintained through the central bore 14 of the tool 10.  
8 At the location of the milling elements 32, movement of  
9 the inner sleeve 20 will cause the springs 36, 38 and 40  
10 to be re-positioned longitudinally with respect to the  
11 tool body 12. Narrow recesses 36 will ensure that the  
12 end of the springs 36, 38 and 40 and located in the  
13 narrow recess 46 will be forced downwards which will  
14 release the opposing end of each spring 36, 38 and 40  
15 from the magnet 42. Once the springs 36, 38 and 40 have  
16 been re-positioned, the milling element 32 will be pulled  
17 radially inwards by the action of the magnets 42 against  
18 the re-positioned springs 36, 38 and 40 with the result  
19 that the milling element 32 will be pulled to a retracted  
20 position away from the walls of the casing. Milling  
21 element 32 will be held in the retracted position by  
22 virtue of the retraction magnets 48 and 50 remaining  
23 attached and attracting the socket head cap screws 56 and  
24 58. Thus, in the disengaged position the milling  
25 elements 32 are held against the tool body 12 and the  
26 milling operation is stopped. In order to prevent  
27 passage of fluid into the region where the springs 36, 38  
28 and 40 and magnets 42, 48 and 50 are located, the inner  
29 sleeve 20 includes a series of 'O' rings 72 and 74.  
30  
31 The principle advantage of the present invention is that  
32 it provides a milling tool where the milling elements can  
33 be disengaged to reduce wear on the elements and on the  
34 casing walls in use.

1  
2 It is a further advantage of the present invention that  
3 the milling elements are held against the tool body when  
4 the tool is disengaged.

5  
6 Various modifications may be made to the invention  
7 described hereinbefore without departing from the scope  
8 thereof. For instance, the number and arrangement of  
9 milling elements may be varied as long as they are  
10 mounted around the tool body and have a milling rib or  
11 profile to interact with a surface of the inner wall of  
12 the casing. Additionally, there may be more than one set  
13 of milling ribs located longitudinally which can be  
14 operated by a single ball drop. It will also be  
15 appreciated by those skilled in the art that a number of  
16 these tools may be mounted in relation to each other on a  
17 drill string each being operated separately by means of  
18 different sized drop balls. Thus, the lowest positioned  
19 tool would have a small inner sleeve so that the drop  
20 ball would be small enough to fall through the central  
21 bore and inner sleeve of the milling tools placed above  
22 it.

1    **CLAIMS**

2

3    1.    A downhole tool for the removal of burrs and other  
4           unwanted material from an inside surface of a  
5           pipeline, well casing or other tubular, the tool  
6           including a tool body mountable on a work string,  
7           the body supporting a plurality of milling elements  
8           which mill the surface and retraction means for  
9           disengaging the milling elements from the surface  
10          when milling is no longer required.

11

12   2.    A downhole tool as claimed in Claim 1 wherein the  
13          tool further includes biasing means to bias the  
14          plurality of milling elements in an outward radial  
15          direction.

16

17   3.    A downhole tool as claimed in Claim 2 wherein the  
18          biasing means comprise springs held under  
19          compression.

20

21   4.    A downhole tool as claimed in any preceding Claim  
22          wherein the tool further includes an outer sleeve,  
23          the outer sleeve including one or more apertures  
24          through which the milling elements protrude.

25

26   5.    A downhole tool as claimed in Claim 4 wherein the  
27          apertures include overhanging portions which engage  
28          a part of the milling element and limit the radial  
29          movement of the milling element.

30

31   6.    A downhole tool as claimed in any one of Claims 3 to  
32          5 wherein the retraction means comprises release  
33          means to remove the compression on the springs.

34

- 1    7.    A dowhole tool as claimed in Claim 6 wherein the  
2        release means comprises an inner sleeve mounted in a  
3        central bore of the tool body into which are located  
4        ends of the springs such that the springs are re-  
5        positioned by virtue of movement of the inner sleeve  
6        from a first position in which the milling elements  
7        are engaged to the inside surface and a second  
8        position where the milling elements are disengaged.  
9
- 10   8.    A dowhole tool as claimed in Claim 7 wherein the  
11        inner sleeve is held in the first position by at  
12        least one shear pin.  
13
- 14   9.    A dowhole tool as claimed in Claim 8 wherein the  
15        inner sleeve includes a ball seat into which a drop  
16        ball can locate such that a pressure build up behind  
17        the ball will force the ball against the inner  
18        sleeve until the shear pin shears and the inner  
19        sleeve falls into the second position.  
20
- 21   10.   A dowhole tool as claimed in any preceding Claim  
22        wherein the retraction means further includes one or  
23        more magnets to hold the milling elements against  
24        the tool body when disengaged.  
25
- 26   11.   A dowhole tool as claimed in Claim 9 or Claim 10  
27        wherein the tool includes a by-pass means which  
28        maintains fluid flow through the central bore by  
29        allowing fluid to by-pass the drop ball when the  
30        tool is disengaged.  
31
- 32   12.   A dowhole tool as claimed in Claim 11 wherein the  
33        by-pass means comprises one or more radial ports in  
34        the inner sleeve and one or more recesses in the

1 tool body such that when the inner sleeve is in the  
2 second position, the one or more recesses are  
3 located adjacent the drop ball and one or more flow  
4 paths are created as the one or more ports align  
5 with the one or more recesses thereby directing  
6 fluid around the drop ball.

7

8 13. A method of removing burrs or other unwanted debris  
9 from an inside surface of a pipeline, well casing or  
10 other tubular, the method comprising the steps:

11

12 a) inserting into the tubular one or more milling  
13 elements;

14

15 b) biasing the one or more milling elements  
16 against the surface to provide a milling action  
17 when the elements are moved in relation to the  
18 surface;

19

20 c) disengaging the one or more milling elements  
21 from the surface to prevent further milling.

22

23 14. A method as claimed in Claim 13 wherein the method  
24 further includes the step of actively retaining the  
25 milling elements in a retracted position away from  
26 the surface of the tubular.

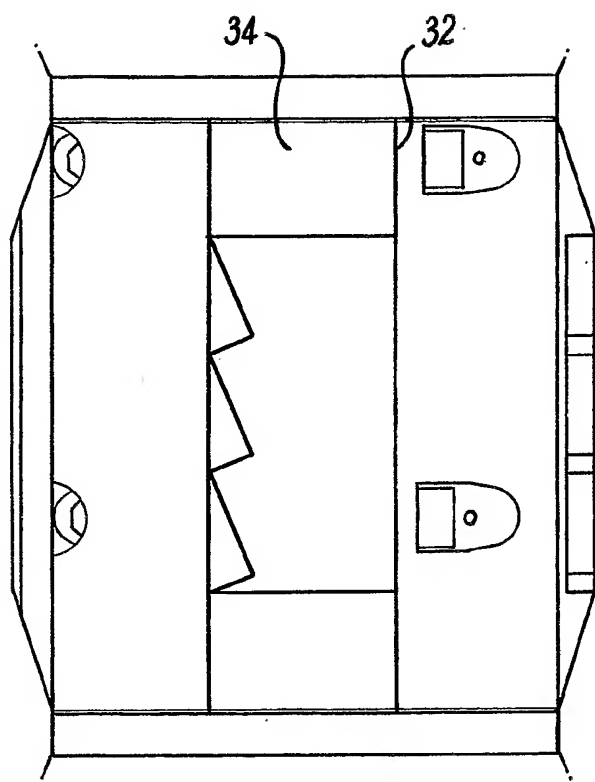
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28 15. A method as claimed in Claim 13 or claim 14 wherein  
29 step (c) includes the step of dropping a ball into  
30 the tool to cause parts thereof to move in relation  
31 to each other and thereby re-position springs within  
32 the tool.

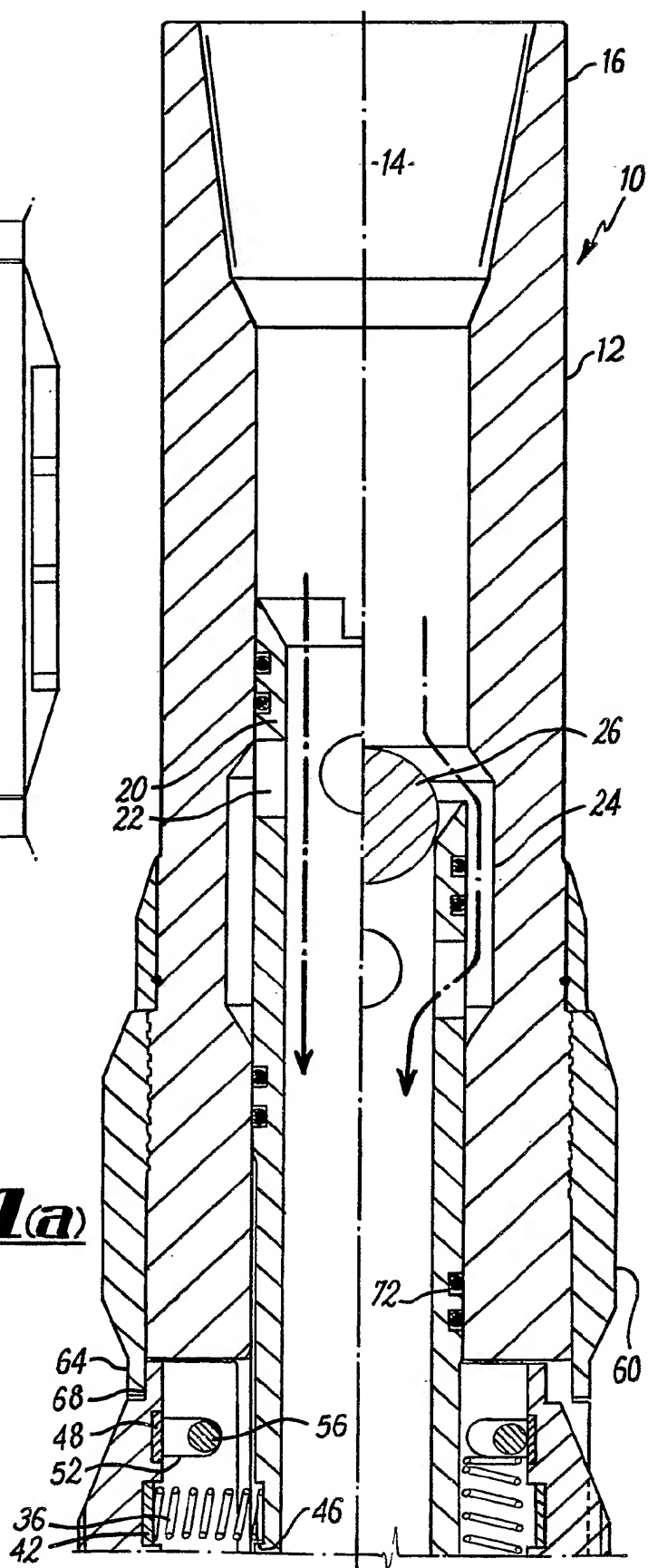
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- 1 16. A method as claimed in any one of Claims 13 to 15  
2 wherein the method includes the step of magnetically  
3 retaining the one or more milling elements against  
4 the tool body when disengaged.



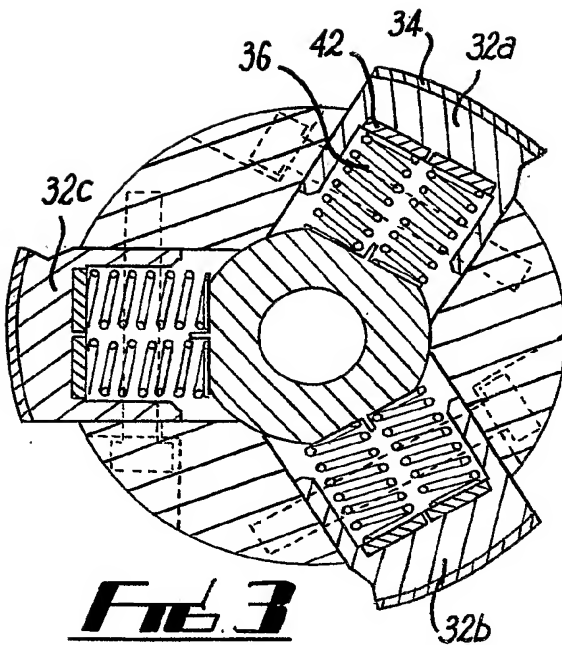
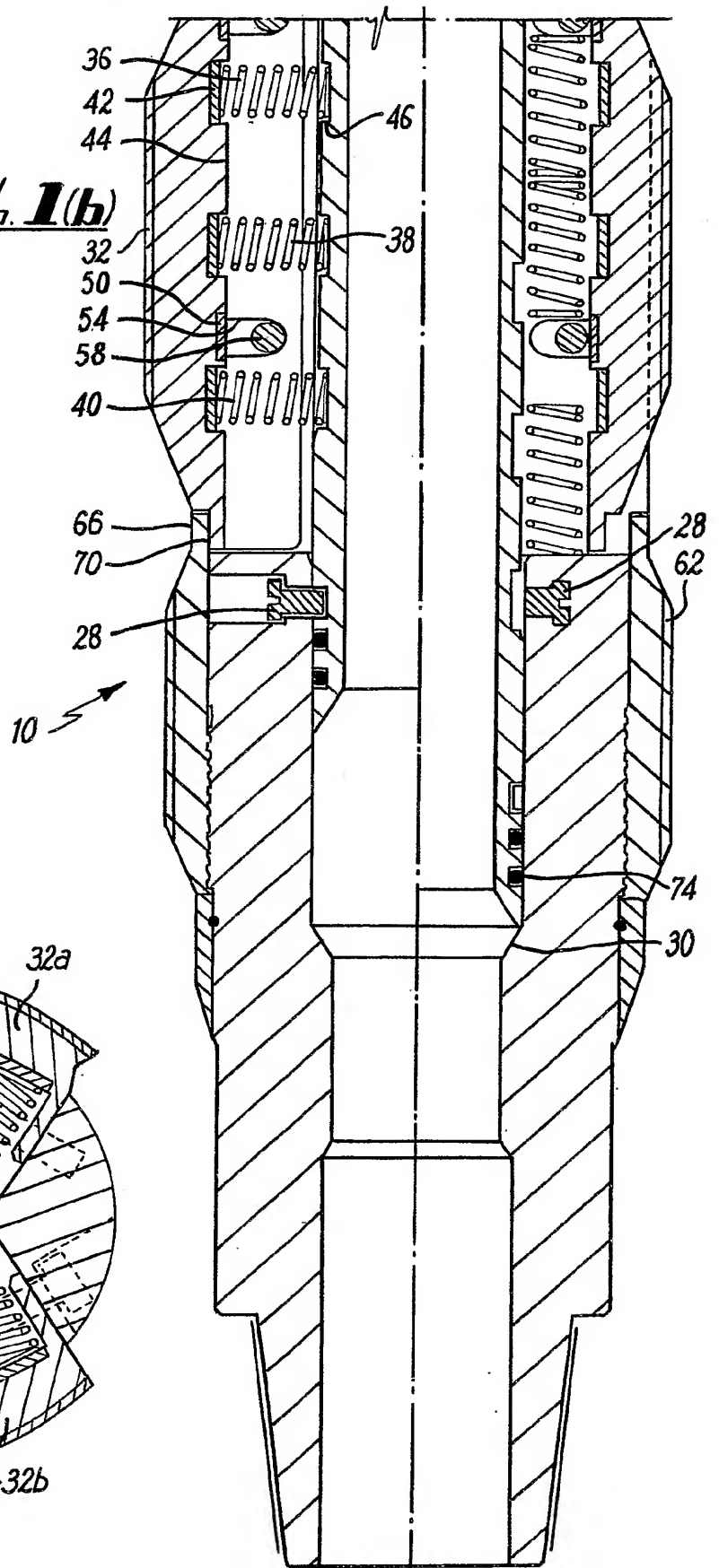


**Fig. 2**



**Fig. 1(a)**

**FIG. 1(b)**



**FIG. 3**

## INTERNATIONAL SEARCH REPORT

Intern Application No

PCT/GB 02/04707

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 E21B10/32 E21B29/00

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

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## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 1 764 373 A (ECKSTEIN OLIVER W ET AL) 17 June 1930 (1930-06-17) page 2, column 1, line 48 -column 2, line 74; figure 3	1,2,13, 14
Y	page 2, column 2, line 120 - line 125	3-5,10, 16
Y	US 5 293 945 A (ROSENHAUCH IRWIN ET AL) 15 March 1994 (1994-03-15) column 21, line 56 - line 62; figures 2,3 column 6, line 46 - line 64	3-5
Y	US 5 361 859 A (TIBBITTS GORDON A) 8 November 1994 (1994-11-08) column 7, line 56 - line 61; figure 1	10,16
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☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

## \* Special categories of cited documents :

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Date of the actual completion of the international search

7 February 2003

Date of mailing of the international search report

14/02/2003

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3 105 562 A (SHIRLEY KIRK R ET AL) 1 October 1963 (1963-10-01) column 1, line 42 - line 52; figures 1,2 ----	1,13
A	GB 2 352 747 A (BAKER HUGHES INC) 7 February 2001 (2001-02-07) See abstract figures 1,2 ----	1,13
A	BE 1 012 545 A (SECURITY DBS) 5 December 2000 (2000-12-05) claims 1,3; figures 1,2 -----	1,13

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